JUPITER AND HIS MARKINGS.

JUPITER is now coming into a favourable aspect in the morning hours. His position about ten degrees south of the equator will, however, be an unfortunate circumstance for European observers. To those, however, who can command an open southern sky, there will be plenty of opportunities for successful research; and, certainly, this magnificent planet deserves all the study that can be possibly devoted to him. In 1899 it is to be hoped that a great number of drawings will be made, and that the latitudes of the belts and spots will be micrometrically determined. We also require a fresh and extensive series of the times of transit of the principal light and dark markings, so that their longitudes and rate of drift relatively to the zero meridian may be ascertained. The latter element requires close attention at every opposition, as the velocities of the various currents are frequently changing, and it is possible they are regulated in definite cycles.

During the last opposition the planet received widespread notice from many observers, including Brenner, Fauth, Gledhill, Hough, MacEwen, Phillips, Comas Solá, Stanley Williams, myself and others. No very special phenomena were presented to arouse so much interest, but the disc was replete with a variety of interesting formations. The equatorial region exhibited an abundant series of dark and bright spots. These were moving more rapidly than similar and probably identical features last year, the difference of velocity being about 10 seconds. It will be important to determine whether a further acceleration of speed occurs in 1899. In 1897 the mean rotation of the equatorial current was 9h. 50m. 34·6s. according to Mr. Williams, while in 1898 the writer found it 9h. 50m. 23·6s.

In the north tropical zone there were several dark elongated spots visible during the last opposition. These completed a rotation in about $15\frac{1}{2}$ seconds less than the red spot. This latitude, about 15° N. of the equator, appears to be very prolific in the production of dark and light spots, which in certain cases remain visible over considerable intervals. During the past few years these markings have presented some difficulties as to their identification, for some of them appear to be subject to variations in form and tint, and perhaps to temporary obscuration. They also, during different oppositions, exhibit a variable rate of velocity. Thus in 1894–5 a very dark and definite spot was seen on the northern edge of the north temperate belt. In the next opposition two other spots, which were known as the "violin" and "garnet" spots, were displayed in the same latitude, though the north side of the belt seemed to have vanished. In 1897 no conspicuous spots were detected in this zone, but several were seen in 1898, and one of these may possibly have been identical with the chief spot of 1894, and with the violin spot of 1895–6, as the following comparison of longitudes and rotation periods, obtained at Bristol, will indicate:—

		Longitude.	Rotation period.
		°	h. m. s.
Dark spot ...	1894 November 5 ...	239·1	9 55 37·8
	1895 May 9	226·3	
"Violin" spot	1895 September 26 ...	222·6	9 55 33·8
	1896 February 9 ...	201·1	
	1896–7 Spot apparently invisible.		
Dark spot "A"	1898 March 23 ...	126·7	9 55 27·7
	July 4	94·7	

The decreasing longitude of the spot agrees fairly well, and the rapid increase of velocity is well marked along the series, but the evidence that the objects were identical is certainly not conclusive. If the spot was temporarily hidden in 1896–7, its rate was probably 9h. 55m. 30·7s. It is curious that in 1890 Prof. Barnard found the rate of a dark spot in same latitude 9h. 55m. 30·3s.; while in 1891 Prof. Hough derived a value of 9h. 55m. 27·4s. from a mean of two spots. From a comparison of a large number of rotation periods of this current at different times, it appears a probable inference that the time oscillates between 9h. 55m. 26s. and 9h. 55m. 41s. in a period of about seven years. This is somewhat doubtful, but the variation of rate seems well marked and to give evidence of regular periodicity. It will be especially interesting to redetermine the rotation period during 1899 if spots are still displayed in this latitude.

With reference to the red spot, I re-observed it on November 29 at 19h. 55m., when it was on the central meridian, and followed the zero meridian of System II. by about fifty-three minutes.

The question has often been asked as to whether the great red spot of modern times is identical with Cassini's spot of 1665 and following years? There seems a large amount of significant evidence to support the affirmative view. The observations spread over the 234 years, from Cassini's first observation to the present time, do not afford many connecting-links, but the probabilities are all on the side of identity.

Though the ancient object is generally called Cassini's spot, it was really discovered by Robert Hooke, with a telescope of twelve feet focus and two inches aperture, on 1664 May 9. He detected, "at about nine o'clock at night, a spot in the largest of the three obscure belts of Jupiter, and found that within two hours afterwards the said spot moved east to west about half the length of the diameter." To Hooke, therefore, belongs the credit of discovering this object, and the indication it afforded of fixing the exact time of rotation of the planet. But Cassini took the marking under his special charge, seeing, as he did, the important deductions to be made from it. Observing it frequently in the summer of 1665, he ascertained the rotation period as 9h. 56m. I have gone over many of Cassini's observations, and make the corrected period of rotation 9h. 55m. 47·5s. in 1665–1672. Cassini says he was assured of the preciseness of one mean revolution to one-eighth of a minute. On 1672 March 1, he saw the spot in transit on two occasions (viz. at 7.30 and 17.26), and announced to the French Academy of Sciences on the following day that the spot might be again seen in transit on March 3 at 9.8 p.m. The Academy thereupon deputed two of its more prominent members to verify Cassini's prediction. With this purpose in view, they repaired to the observatory, and, in company with Cassini, actually observed the spot return exactly as foretold by him.

The spot seen by Hooke and Cassini was about one-tenth of the apparent diameter of Jupiter; this would be about 9000 miles, and equivalent to the width of the spot in recent years. The oval shape it now presents may be due to the rapid rotatory motion of the sphere, which we know has the effect of spreading out objects in a longitudinal direction. Several new belts have been formed under the eyes of observers. But in the case of the red spot, its material may have been sufficiently solid to withstand the winding-out process beyond the elliptic form which became its permanent shape.

If the spot which Hooke saw on 1664 May 9, was the same as the relic of the red spot observed at Bristol on November 29 last, then in the interval of $85,670\frac{1}{2}$ days no less than 207,084 rotations have been performed, if we adopt the mean rate as 9h. 55m. 40s. during that long interval. It is quite possible to trace back the spot or its accompanying hollow in the great southern belt to 1831, and a further search amongst old drawings of Jupiter may take its history safely back to the time of Sir William Herschel and J. H. Schroeter. W. F. DENNING.

THE NEW LIVERPOOL MUSEUMS EXTENSION BUILDINGS.

THE present museums buildings were erected in 1860 by the late Sir W. Brown for the splendid natural history collections bequeathed to the City of Liverpool by the XIIIth Earl of Derby in 1851. These were so extensive that the accommodation they required necessitated the building of what was, at that time, one of the largest museums in England outside the Metropolis. Since that date the collections have been constantly added to, not so much by purchases, as by gifts —some of them of the highest value—from donors possessing an interest in natural science, and appreciating, in advance of their time, the importance of that subject as a means of education, with the result that, to-day, every available foot of space in the museums has long been occupied—every cellar even being stored to its utmost capacity—so that any intelligible arrangement of their contents has now become well-nigh impossible. Within the past decade, also, the change in the public attitude has been growing very rapidly towards an appreciation of museums as institutions of high educational value and importance. This is due, no doubt, to the rapid increase of scientific and technological knowledge, and to the advocacy of no one in Europe so specially as Sir William Flower, who, by his writings, and, perhaps, principally by the methods, inaugurated by him, of displaying and labelling the specimens in the Natural History Museum in South Kensington, has made manifest, not the interest only, but the educational value of the study of natural objects. The Corporation of Liverpool has been one of the first to recognise this advance in opinion in raising the city's museum to the position of a first-class scientific institution, by voting the necessary funds for its proper support, and keeping the collections abreast of the stream of discovery.

The additions—chiefly by purchase—to both the Derby and Mayer Museums have been within the last three or four years so specially numerous that since 1893 it has been evident to the Museums Sub-Committee of the Libraries, Museums, and Art Committee of the Council that increased space was urgently necessary.

The Technical Instruction Sub-Committee then also found itself in the same position in regard to a central school to accommodate the more advanced classes, which were and are now being held in widely separated parts of the city, in buildings most of them ill adapted for teaching purposes.

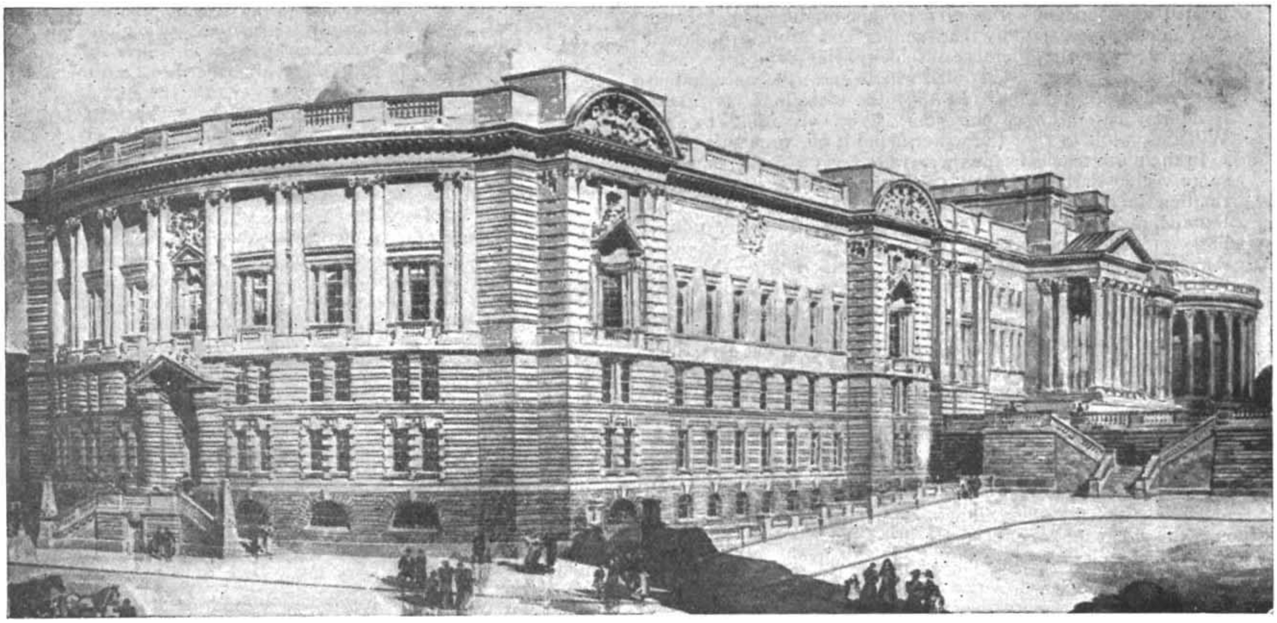
A special Sub-Committee was therefore constituted in December 1894, empowered to take immediate steps for the extension of the museums, and for providing suitable accommodation for the Liverpool School of Science, Technology, and Art. The credit of overcoming the difficulties which beset the initiation of so large a scheme, and of arranging the preliminaries, is chiefly due to Sir William Forwood.

The present museum buildings stand on a rocky plateau sloping abruptly towards the west. By excavating this slope, consisting of Permian rock, down to the level of Byrom Street, sufficient accommodation, three stories in height, could be provided for the Technical Schools, while the museum galleries could be carried forward, on their present level, over the schools. The Technical Schools will thus be distinct and entirely isolated, and have their own entrance in Byrom Street.

This being so, designs with estimates for a building—whose requirements were sketched out by the Director of Technical Instruction and the Director of Museums respectively—were invited from a selected list of architects of eminence in England. In the summer of 1896 the designs of Mr. Edward William Mountford, of London, were awarded the first premium. The handsome and stately building so designed, which is represented in the accompanying illustration, will be 90 feet above the level of Byrom Street, and measuring from north to south 162 feet, and from east to west 190 feet, occupying an area of 27,000 square feet. The galleries of the museum will run in continuity with those in the existing building, and will be undivided in any part of their course by walls or partitions. They will be of horse-shoe shape, and 420 feet in length, 33 feet in breadth; the lower—to contain the Invertebrates—19 feet in height, while the upper—for the Vertebrates—will be 27 feet. The lower floors will be lighted from the side, and the upper from the roof. New and well-appointed laboratories—which, when the first building was erected, had been entirely overlooked, or, at that date, considered quite unnecessary adjuncts to a museum—for the director and his assistants, are also to be provided, as well as new administrative offices.

The new buildings will be of brick, faced with Stancliffe stone from the quarries at Darley Dale, in Derbyshire, the same which furnished the material of which St. George's Hall is built. They will be the largest built by the Corporation of Liverpool for fifty years, and the largest since the erection of St. George's Hall, and, next to it, the largest building in the city. The front to Byrom Street rises from the very edge of the original "Pool," and is close to the site where the old bridge connected Liverpool with the heath.

The ventilation and heating of the buildings will be carried out on a system which provides upwards of four miles of three-inch pipes, discharging into every room purified and warmed air to the amount of 8,000,000 cubic feet per hour. The stairs are of stone, the floors of concrete, and the roof chiefly of steel, so as to reduce the chance of fire to a minimum; in case of which, however, an emergency staircase will provide exit for visitors in the museum.



The New Central Technical Schools and Museums Extension Buildings, Liverpool.

The work of excavating the rock, of which the slope extending west of the present museums is composed, was commenced on November 1, 1897.

On July 1 last the foundation stone was formally, and very appropriately, laid by Alderman Sir William Bower Forwood, who has for many years been Chairman of the Standing Committee in charge of the libraries, museums, and art gallery, and to whose energy and powerful advocacy, not only the approaching realisation of this much-needed extension of the two departments of technical instruction and the museums are, in a very special manner, due, but also the large increase and development of the two other departments under his chairmanship—the libraries and the art gallery.

On the stone being "well and truly laid," Sir William Forwood gave an interesting address, in which he said the City Council, by that day's proceedings, announced to Liverpool that they believed that technical instruction had come to stay with them; that it was now part of the life of the people; and that it was worthy of that magnificent home. This building would complete what he believed would be the most unique group of buildings in the world. It was intended for the higher technical education—for educating the captains of labour, and not merely the artisans, in a way that would enable them to meet the competition of Germany. The Germans had had these superior schools for years, and had been turning out a large number of expert and scientific men such as did not exist in England. They, however, hoped to make them exist in Liverpool, and he also hoped that this building would enable them to start in Liverpool many new industries that would give employment to the surplus population, and especially to females.

Speaking of the accommodation which would be afforded to the museum, Sir William reminded them that it had been founded by a bequest by the XIIIth Earl of Derby, some sixty years ago, and had been strengthened year by year by purchase. They were able to display only about one-half of their collections, and even that was so crowded that it was impossible to attempt any classification. This building would enable them to unpack and arrange scientifically the whole of their treasures, and in a short time they would have a museum unequalled out of London. When visiting Rome, Florence, Venice, and Athens, they were attracted there, not by what the Cæsars and Doges had done, not by the spoils of war, but by the monuments of art and the stores of literature which were left behind in these cities. In the same way he hoped that these buildings would tell future generations that, while they had been strenuously engaged in commerce, they had not been forgetful of the intellectual welfare of the citizens, knowing that by doing so they were promoting public morality as well as the material prosperity of the people.

ECONOMIC BOTANY IN NYASALAND.

THE following interesting notes on some of the exotic economic trees and shrubs cultivated in the Residency Grounds, Zomba, British Central Africa, are given by Mr. John Mabon, Government Botanist, in the annual report on the Protectorate for the year 1897–98 (C-9048). Accompanying the notes in the report is a complete list of exotic trees and shrubs growing at Zomba.

The collection of exotic plants grown at Zomba possessing economic value is not at present very extensive, but it is being steadily added to. The Coffee-disease Regulations in force prevent plants or seeds being imported from several tropical centres where we could obtain many valuable things, and the long journey from England hinders us from obtaining plants in Wardian cases from the Kew establishment or any of the large nurseries, except the consignment is taken in hand by some officer of the Protectorate, or the like, who is making the voyage out and sees it safely through. The authorities at Kew, having such unusual opportunities for distributing seeds, frequently forward valuable material to us, and many of the items mentioned emanated from Kew, either as seeds or plants. The list forms an interesting record of the cultural possibilities in the climate of the Shiré Highlands. There are but few countries where one can see such an essentially cool and northern type of vegetation as the Lawson cypress (which bears seed in enormous quantities) growing alongside such an essentially tropical type as the gutta-percha of Malaya (*Dichopsis gutta*). Although it is true the latter does not reach its proper degree of development, yet it is perfectly healthy, and it points to the fact that in the lower and warmer region on the Shiré River it would be a valuable culture.

Many of the items mentioned are only represented by one plant, and many of them are not old enough to have reached the fruiting period. Some of the introductions grow with surprising vigour. For instance, eucalyptus, the seeds of which were sown about six years ago, are now over sixty feet high, and would yield very capable timber if required. The well-known blue gum is not, however, a success here, but it seldom is in these latitudes below the 5000 feet level. Still there remains numerous equally good, and even better, members of this useful genus which we can cultivate with success.

Mauritius hemp (*Furcræa gigantea*) and sisal hemp (*Agave rigida*, var. *sisalana*) grow with great freedom, and while it would scarcely pay to cultivate these valuable fibres at present for the European market, yet if any textile industries arise locally there can soon be plenty of raw material at hand to supply them.

Seeds of the celebrated China grass (*Boehmeria nivea*), a fibre very much in demand now, have been ordered, and it is intended to demonstrate that it is a profitable culture that might be grown in Nyasaland with the object of exportation to the European markets. Arnatto (*Bixa orellana*) fruits with great profusion; the seeds are used in the arts as a dye, and as colouring agent for butter; the supply at present, however, from Colonies like the West African, exceeds the demand.

Fruits are a very important culture in all tropical countries, and the indications point to the Shiré Highlands being suitable for raising the fruits of many diverse countries. The mango (*Mangifera indica*) grows with much luxuriance, but as all the existing plants at Zomba have been introduced recently they have not yet reached the fruiting stage. One tree is expected to yield some fruit this year. The same applies to oranges, avocado pear, and guavas, although at present one tree of the latter is maturing fruits. (On the Buchanan estate, close to the Residency, oranges bear with great profusion, and up till recently peaches were a great success there.) The granadilla (*Passiflora quadrangularis*) fruits freely, and the fig (*Ficus carica*) seems quite at home. The grape vine grows well, and is a recent introduction; we expect to see it fruiting next year. Bananas, it need hardly be remarked, bear with great abundance. Up to the present this is practically the only fruit the native grows.

Exotic timber trees are very promising. The red cedar (*Juniperus virginiana*) and West Indian cedar (*Cedrela odorata*) do extremely well, and are important in view of the expected development of the tobacco industry, as they supply material from which first-rate cigar boxes can be manufactured. Kauri pine (*Dammara Australis*), a timber of great value and utility, promises to become a great success here, for seedlings planted a year ago have reached over three feet in height. Mahogany does very well. The good offices of Kew have been requested in obtaining for us a large quantity of seeds in order that we can grow it on a considerable scale and distribute it over the Protectorate. The splendid Mlanje cedar (*Widdringtonia whytei*) grows with unexampled vigour at Zomba, which is at least 3000 feet lower than its native habitat. It is very interesting to find it doing so well here, and points to the fact that in time the hills of Nyasaland above the 3000 feet level can be successfully forested with this excellent timber. Seeds from the trees at Mlanje have been widely distributed amongst Government officers, missionaries, and planters in the Protectorate, as well as to various parts of Southern Africa.

Perhaps enough has been said to indicate the diversity of cultures possible in the Protectorate. The Botanical Department at Zomba is very young yet, but endeavours are being made to render it of service to the country. As it is, it can demonstrate that many plants of commercial importance find a suitable home in the soil and climate of Nyasaland.

THE IRON ORE DEPOSITS OF NORTHERN SWEDEN.

OF the excursions in connection with the last meeting of the Iron and Steel Institute in Sweden, none was of greater interest than the visit to the vast mountains of iron ore at Kiirunavaara and Luossavaara within the Arctic Circle. The party of members invited by the owners of the mines was necessarily limited, and the journey was long and arduous. After travelling 820 miles by railway, the party proceeded in carriages for forty miles over a loose shingle road, then for forty miles more up the Kalix river in boats poled against the stream, and lastly for ten miles on foot. The visit to the mines was made under the guidance of Mr. H. Lundbohm, of the Geological Survey of Sweden, who contributed to the meeting an interesting paper describing the deposits. From this the following details are derived:—

The character of the country is very remarkable. The Kiirunavaara mountain consists of a steep ridge extending for about 2½ miles, divided into a series of peaks varying in height from 270 to 2450 feet above the lake Luossajärvi, which separates it from the gently sloping conically shaped Luossavaara. On the tops of these mountains the ore lies almost entirely uncovered by soil; on the sides it is covered by morainic material and beds of gravel and sand; while the mountains are